Gut microbiome

a game-changer for the food industry

The gut microbiome is gaining recognition as one of the starting points for personalised nutrition. With 32% of adults globally wanting products that match their personal dietary and nutritional needs more readily available[1], and consumers starting to become aware of the relationship between diet, the gut and health, food manufacturers are keen to tap into this emerging demand. In order to secure a slice of the market and earn consumer loyalty, food & drink manufacturers must prove that their products can deliver the promised benefits. Leatherhead Food Research's Dr Pretima Titoria and Professor Kathy Groves examine why, how and when the gut microbiome can potentially revolutionise the food industry.

Human health is strongly influenced by the gut microbiome – a microbial community that is associated with the gut habitat (the large intestine). Within the gut microbiome are clusters of bacteria and other microbes called microbiota, which contribute to our general health and well-being by regulating metabolism, influencing our immune systems and even how we respond to treatments such as cancer therapy.

Critically, it is the diversity of the gut microbiome that is key to optimal health; an imbalance within the microbial communities can lead to poor health or 'dysbiosis'. The creation of a diverse microbiota starts from birth (or probably in the uterus), with the birthing process and feeding method having an impact on gut microbiota.[2] Subsequent influencers are diet (type and geographic) and external factors such as lifestyle stages, stress, intake of antibiotics and medicines.

Role of gut microbiome in health

Microbiota, the most recognised of which are *Bifodobacterium* and *Lactobacillilus*, generate nutrients or bioactives from substrates that are otherwise indigestible by the host. Bioactives include: vitamins, for example K, B12 and biotin; enzymes, which are important in the breakdown of carbohydrates and complex substrates; short chain fatty acids (SCFAs) which provide an important source of energy for intestinal mucosa and modulate immune responses in cancer and colitis; and secondary bile acids, which are important in facilitating lipid transport. These bioactives are taken up by gastrointestinal tissues and distributed to other tissues via the circulatory system.

However, gut bacteria also produce gases such as methane, hydrogen and carbon dioxide as they digest and ferment foods; an excess of these gases can cause bloating, pain and flatulence. Some of the by-products of microbiota can also be toxic, depending on the substrates being fermented, leading to tissue inflammation and/or contributing to disease.

Health beyond the gut

In terms of health benefits, consumers tend to associate their gut with digestive disorders such as irritable bowel syndrome (IBS), colorectal cancer, weight management and gut infections. However, there is an increasing amount of research-based evidence demonstrating that the role of the gut microbiome extends further than the gastrointestinal tract. 'Gut-lung axis' and 'gut-brain' axis are new terminologies coming up, following recognition of the relationships between diet and illnesses outside the scope of the gut. For instance, a collaborative study between Nestlé, Lausanne University, Novartis, CHUV and EPFL demonstrated that a diet rich in plant fibres reduced pathological manifestations (i.e. characteristic symptoms of an illness) in the lung[3] – a prime example of the gut-lung axis.

Ingredients for enhancing gut microbiome

Developing ingredients and food products to promote desirable bacterial (probiotic) communities within the gut will be of primary interest to the food industry over the next five to 10 years as part of the drive towards 'personalised nutrition'. A number of probiotic products currently dominate the market, such as dairy products reinforced with live microorganisms, freeze-dried microbe supplements and natural fermented products such as kefir, natto, and tempeh, all of which contain bacterial masses.

In addition to probiotics, prebiotics are also gaining attention. Prebiotics are mainly indigestible dietary fibres that are fermented by the bacteria in the colon and which contribute to maintaining and improving the intestinal microbiota, particularly when dysbiosis exists.[4] Dietary fibres include soluble fibres (e.g. pectins, oligofructose, β-glucans) which are fermented into SCFAs and gases by colonic bacteria, and insoluble fibres (e.g. celluloses and hemicelluloses), some of which are fermented to SCFAs.[5]

Exciting research is being undertaken in the drive to find innovative ingredients and solutions. Soluble non-starch polysaccharides (NSPs) from plants including broccoli and plantain banana are showing promising results.[4] Furthermore, non-fibre ingredients such as polyphenols are gaining attention by possibly providing a protective effect against inflammation and obesity.[5]

Fortifying products with dietary fibres, or the development of high-fibre products, is universally accepted as supplementing the gut microbiome in a positive way (although there are some restrictions for IBS sufferers). However, the ability to target dietary fibres to the right parts of the colon is an exciting area that would have the most impact on supporting the diversity or resolving an imbalance of the gut microbiome.

However, there have recently been news stories, whereby certain ingredients have been identified as potentially having a detrimental effect on the gut microbiome. Research has indicated that chemical emulsifiers may be linked with obesity and inflammatory bowel disease in mice[6], and that artificial sweeteners could potentially cause metabolic diseases such as obesity and diabetes by changing the makeup of the bacteria in mice[7]. However, these headlines should be addressed with caution as there can be many multidisciplinary factors playing within these studies. Therefore further research is needed to evaluate, understand and establish the full effects of these ingredients on the gut microbiome. Furthermore, it must be stressed that the extrapolation of such data from mice to humans is still contentious.

Challenges and progress

Enormous potential in personalised nutrition is driving the food & drink industry to overcome the key challenges. New, accurate and sophisticated product development, processing and analytical technologies are bringing the goal closer. In the longer term the microbiome will become increasingly important in health and nutrition research.

New probiotics in terms of species, sub-species and specific health benefits are being identified through high-throughput sequencing/next-generation sequencing technologies. In addition, considerable research is being undertaken on the survivability of probiotics through manufacturing processes and acidic gastric environments. Probiotics need to reach the colon intact to impart their health benefits, so this area is a must for product development. Microencapsulation with different polymers and the addition of specific complementary ingredients which have a protective effect on probiotics are just two areas being researched. Another area that holds promise is the development of synthetic engineering of microbiota; Eligo Bioscience is developing a new family of the so-called eligobiotics, a bacteriophage-based platform which will target pathogenic bacteria in the gut microbiome but leave the surrounding microbiome untouched and ready to re-establish its healthy balance.[8]

With respect to prebiotics, the key challenge is including a minimum amount of dietary fibres to induce a positive effect on the gut microbiome.[9] Not only do dietary fibres have a significant impact on texture, rheological and sensory properties, manufacturing processes can also affect the composition and functionality of the fibre. Although it will take trial and error with a wide range of dietary fibres and emerging ingredients such as polyphenols these, together with progressive processing technologies, will enable product developers to succeed.

Ongoing and emerging developments need to be regulated, so as to protect consumers. Whilst a number of health claim applications for probiotics have been submitted to the European Food Safety Authority (EFSA), none have been granted to date. Therefore, in the absence of any approved health claims, manufacturers are limited to including the name of the probiotic bacteria on the ingredients' list on the product packaging. To assist applicants in preparing health claim applications, EFSA published 'Guidance for claims on the immune system, GI, and defence against pathogens' in 2016.[10] The document indicates the types of evidence needed to support the claims – for example there should be proof that the probiotics survive manufacturing and storage, that they reach the colon through the gastrointestinal tract and that the presence of the probiotics has a beneficial physiological effect.

So where do we stand?

It will be at least another decade or two before probiotic/prebiotic products with supporting health claims become available on the market. Even though it will take time, companies are currently making significant investment in this area of research with the aim of owning proprietary patents on microbiota and associated products. The gut microbiome offers huge potential for revolutionising personalised nutrition and it will be exciting to see how this develops in the future.

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